Journal of Surgical Oncology 1997;66:285–295

REVIEW ARTICLE

Interstitial Implantation of Gynecologic Malignancies

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Interstitial implantation is invaluable in the management of patients with extensive or large volume gynecologic malignancies, significant anatomical distortion, or recurrent disease. Such techniques are necessary components of the brachytherapy services available to patients with gynecologic malignancies giving superior results in terms of local tumor control and survival compared to those achieved with external beam alone or inadequate intracavitary applications. Local tumor control with an acceptable risk of complications can be achieved for these challenging disease presentations if these techniques are implemented skillfully through the joint efforts of the radiation oncologist and gynecologic surgeon.
J. Surg. Oncol. 1997;66:285–295.

KEY WORDS: brachytherapy; cervical; vaginal; needle

INTRODUCTION

Large volume gynecologic neoplasms present a therapeutic challenge. With external beam irradiation alone, achieving the curative radiation doses required may be impossible because of the limited tolerance of the interposed small bowel, rectum, and bladder. Standard intracavitary applications may be prohibited either by tumor bulk or distorted normal anatomy. Transperineal interstitial implantation in these clinical settings is a superior alternative to intracavitary techniques (Table I). Interstitial implantation overcomes the limitations of intracavitary techniques in terms of treating the disease precisely and providing a wider more uniform distribution of radiation in the pelvis [1].

Beginning in 1914 [2], free-hand transvaginal or laparotomy-guided radon and radium needle implantation were used extensively in the definitive treatment of vaginal and cervical carcinomas or as a preoperative or postoperative adjuvant. Intraoperative permanent gold or iodine seed implantation was also used for disease not encompassable by needles. With both needle and seed implantation, source positioning was unpredictable, even in the best of hands.

The template concept, introduced in 1942 [3,4], allowed for a predictable distribution of needles inserted across the entire perineum through a perforated template according to an optimum pattern [5]. Subsequently, *afterloading* of template-guided hollow stainless steel needles with radioactive sources limited the radiation exposure to medical personnel [6,7]. Iridium-192 (Ir-192) sources became available in the 1950s offering a wide variety of sources readily accommodated by longer smaller caliber needles than necessary for radium [8–10].

Due to rapid advancement in external beam methodology during the 1960s and 1970s, interstitial implantation fell into relative disuse. Renewed interest emerged in 1974 [11] with the development of a prefabricated perineal template, the MUPIT (Martinez Universal Perineal Interstitial Template, Beaumont Hospital, Royal Oak, MI), through which steel needles were inserted and afterloaded with Ir-192 or I-125 [12,13]. Concurrently, Feder et al. [14–16] revived Waterman's approach [17] of interstitial implantation of extensive cervical carcinomas and vaginal carcinomas utilizing the Syed-Neblett transperineal template system. Transperineal interstitial

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Accepted 4 August 1997

TABLE I. Indications for Interstitial Implantation

Cervical carcinoma
Bulky disease (including stage IVA)
Narrow vagina
Loss of endocervical canal
Distal vaginal involvement or extensive proximal vaginal involvement (>0.5 cm thick)
Cervical stump
Persistent disease after external beam and intracavitary implantation
Advanced vaginal carcinoma (vaginal disease thicker than 0.5 cm)
Advanced endometrial carcinoma
Recurrent gynecological carcinoma after surgery or prior radiation

implantation techniques currently employed are traceable to the evolution of these two systems.

MATERIALS AND METHODS

Applicators

The MUPIT [12,13,18,19] template (Fig. 1) accommodates implantation of multiple pelvic-perineal malignancies (prostate, anorectal, gynecologic) [20] with recent modification for high dose rate (HDR) techniques for vaginal and cervical carcinomas [21].

Currently there are three Syed-Neblett templates (Best Industries, Springfield, VA) of varying size and shape for use in implantation of gynecologic malignancies (GYN 1-36 needles; GYN 2-44 needles; GYN 3-54 needles), as well as templates for implantation of the rectum, prostate, and urethra (Fig. 2) [15–17,22,23].

The Syed-Neblett system and MUPIT are particularly suited for treatment of vaginal disease as the vaginal obturator needles can be strategically loaded to encompass disease from the fornices to the introitus. Additionally, the obturator needles can be advanced directly into the cervix, along with a uterine tandem, and may be essential to deliver tumoricidal radiation doses to the cervix by preventing a central ''cold spot,'' especially if an intrauterine tandem is not used. The more peripheral needles are used for implantation of the parametria.

Modifications of these standard templates have evolved [24–27] and other innovative templates developed for vulvar, vaginal, and cervical carcinomas [28–32].

Insertion Techniques

Preoperative preparation. Preoperative evaluation prior to implantation routinely includes electrocardiogram, chest X-ray, complete blood count, prothrombin time (PT), partial thromboplastin time (PTT), and serum chemistries. Patients must have a bowel-clearing routine. Betadine vaginal and perineal preparations are given in the operating room and a bladder catheter is inserted. Intravenous antibiotics are given perioperatively.

Epidural catheter placement prior to needle implantation is recommended [33,34]. The epidural contributes to pain control during needle insertion and is preferred for postoperative pain management. Monitored anesthesia is also administered to relax the patient during needle insertion. General endotracheal anesthesia is needed only if laparoscopy or laparotomy are used to guide needle placement.

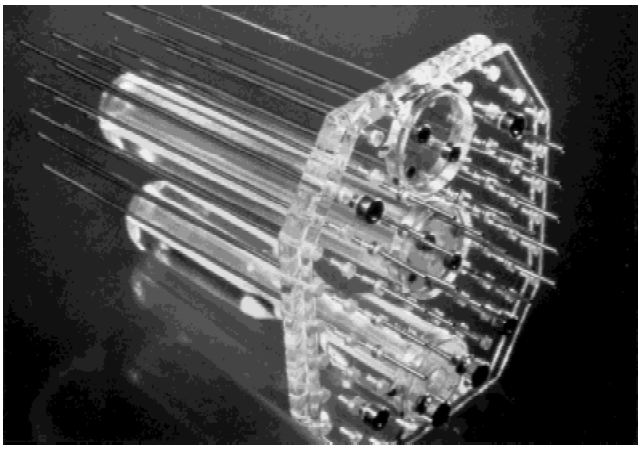

Fig. 1. The MUPIT consists of a flat acrylic template and a flat acrylic cover plate, two sets of acrylic cylinders of different diameters to accommodate differences in anatomy, obturators, screws, and 17 gauge stainless steel blind-ended needles of different lengths. (Courtesy of Alvero Martinez, MD)

Insertion. Insertion should be performed by a radiation oncologist and gynecologist working as a team. Pelvic examination under anesthesia in the dorsal lithotomy position is performed to assess tumor dimensions and extensions, the proximity of other pelvic organs, and the uterine position. Uterine sounding and dilatation of the endocervical canal follow, and metallic markers are placed to demarcate the cervix and/or the upper and lower boundaries of any vaginal disease extensions for reference on orthogonal radiographs (Fig. 3). If there is a patent endocervical canal, a tandem may be inserted. If a tandem cannot negotiate the canal, a 25 cm guide needle may be inserted instead [35]. A vaginal obturator with sleeve is then threaded over the tandem [36]. The perineal template is then threaded over the obturator, and positioned flush against the perineum. Either 17 gauge stainless steel (open or close-tipped) or plastic flexiguides 20–25 cm in length are then inserted [28,37].

The choice of template holes accessed is based upon the location of the tumor. Both symmetric and asymmetric loading of the template have been described for circumferential or unilateral extension of paracervical disease [18,23,38]. Needles must be inserted beyond tumor both laterally and in a cephalocaudal direction to obtain adequate tumor coverage [39]. Template holes nearest the bladder and rectum are usually avoided unless vesicovaginal or rectovaginal septal involvement or urethral involvement is present. Interference from the pubic bones may preclude use of some needle holes anteriorly

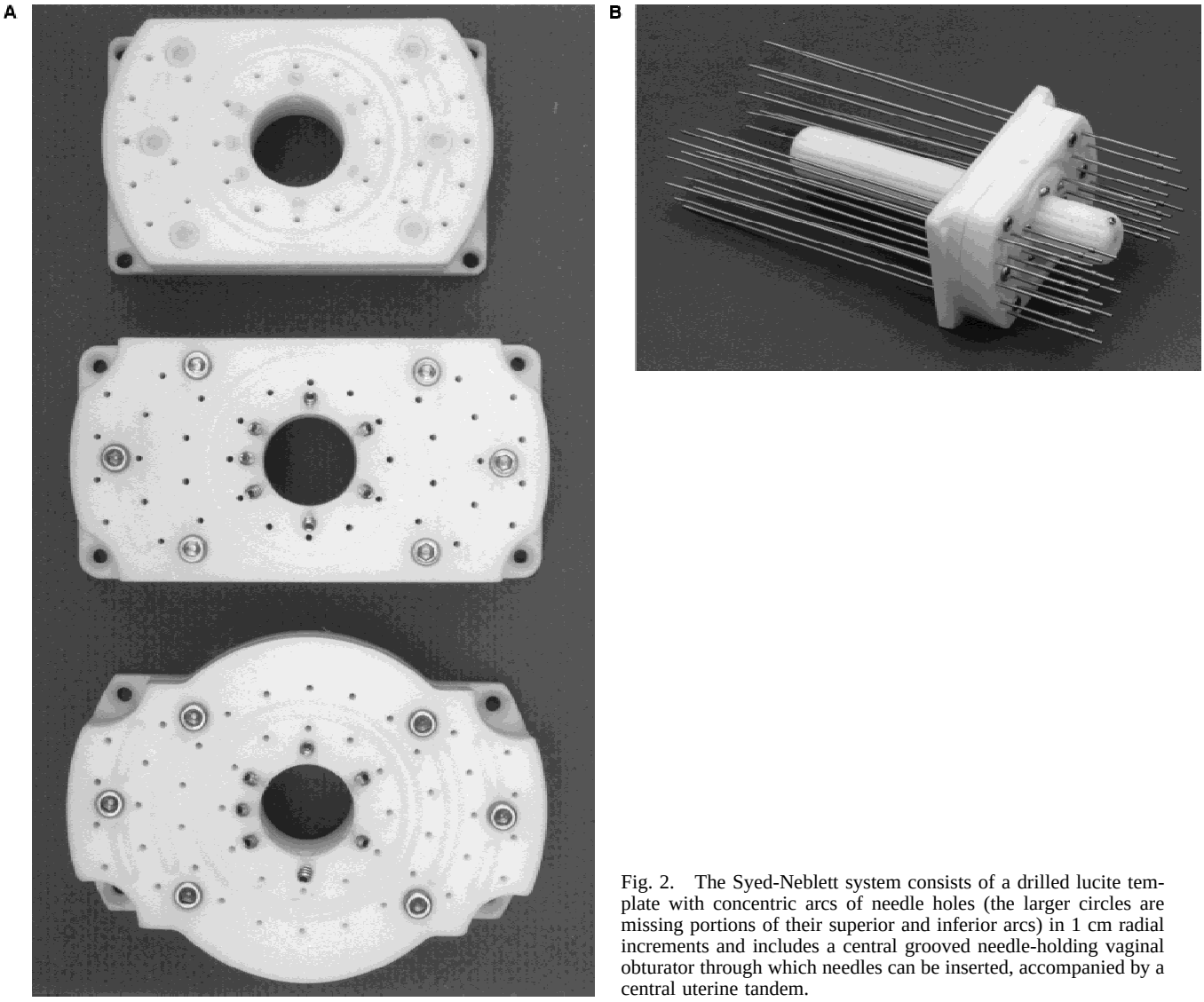

Fig. 2. The Syed-Neblett system consists of a drilled lucite template with concentric arcs of needle holes (the larger circles are missing portions of their superior and inferior arcs) in 1 cm radial increments and includes a central grooved needle-holding vaginal obturator through which needles can be inserted, accompanied by a central uterine tandem.

and laterally. It is not necessary to implant disease above the lower uterine segment unless required by upward tumor extension [13,18]. Since the dose falls off near the needle tips, they are inserted several cm beyond the target volume, when possible, to ensure adequate coverage [32,39,40].

Preoperative MRI and CT are helpful to determine the depth of needle insertion and identify problematic anatomical situations such as an anteverted uterus overlying the bladder dome, suprauterine sigmoid, pelvic small bowel, a deviated or ''horned'' bladder, or massive disease [30,41]. Fluoroscopic guidance during needle insertion can also ensure parallelism and optimum depth of insertion [35,42]. Intraoperative transabdominal ultrasound may be performed to guide needles close to the bladder, and to further confirm the appropriate depth of needle insertion by visualizing the endocervical canal, cervico-uterine junction, and uterine fundus, and their relationship to the advancing needles [43].

Once the depth of insertion has been determined and documented by measuring the needle protrusion from the template, placement of the remaining needles is accomplished after the bladder is drained. Needles nearest the rectum are inserted with a guiding rectal finger to avoid penetration. Cystoscopy and proctosigmoidoscopy are sometimes used to rule out rectal and bladder penetration at the end of the procedure [26,41]. Methylene blue or indigo carmine dye instillation into the bladder can be used to rule out bladder penetration [41]. Needle depth can also be determined with the aid of laparoscopy or laparotomy and is strongly recommended in the post-hysterectomy setting where any adherent bowel may be freed from the vaginal cuff. Laparoscopy use reported in several series [41,44], sometimes discourages optimum needle placement because of the fear of penetrating intervening bowel loops. Additionally, it is not possible to visualize needles buried in the retroperitoneal pelvic tissues or bladder. Laparotomy is particularly helpful as

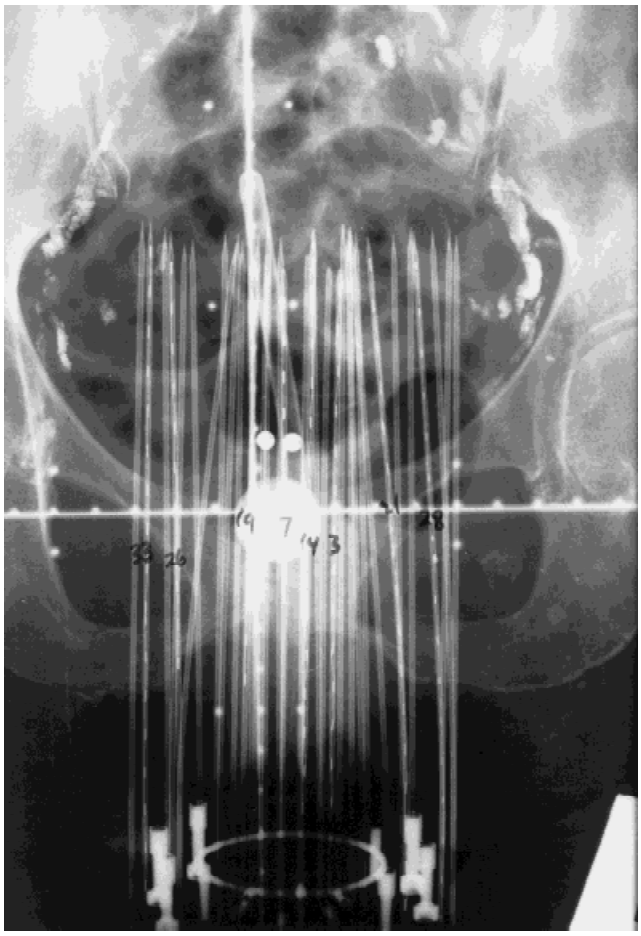

Fig. 3. AP radiograph Syed-Neblett template, needles, and tandem. Note: Cervical marker balls above bladder catheter bulb. ''Dummy'' sources are in several central and peripheral needles. (Reprinted, with permission from Erickson B, Albano K, Gillin M: CT guided interstitial implantation of gynecologic malignancies. *International Journal of Radiation Oncology • Biology • Physics* 1996;36:699–709. Elsevier Science Inc.)

the needles can be manually guided by two teams from the perineum to the lower abdominal cavity [41,45–47]. This is especially helpful for patients with problematic anatomy or with adherent pelvic bowel or prior hysterectomy but does require a major abdominal procedure. We have found CT scanning extremely useful for confirming that the needles have been inserted to the proper depth [48] (Fig. 4).

Once the needles have been appropriately inserted, they are fixed in position by tightening the large template screws. Measurement of needle protrusion from the template confirms the intended depth of needle insertion. The template is sutured to the perineum via holes at the corners of the template and covered with bandages. The patient is transferred to the recovery room in a frog-legged position and epidural anesthesia optimized. Orthogonal radiographs for dosimetric analysis are obtained (Fig. 3).

Ir-192 sources are ordered on the day of surgery. Typical Ir-192 source train lengths are 7.3 cm (range 4–12 cm), with the sources at the center of the implant typically having one-half to one-third the activity of those at the periphery (0.13 mCi/seed vs. 0.37 mCi/seed) [12,23,49].

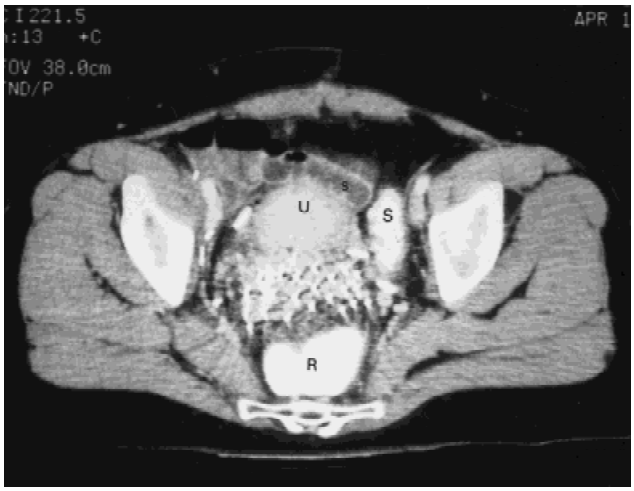

Fig. 4. Axial CT distinguishing sigmoid (S) and rectum (R) filled with contrast, adjacent to anteverted uterus (U) and cervical needles.

Source loading is accomplished the following day and their position verified with radiographs. Modifications of the planned source placement can be made prior to loading or during the implant. Plastic caps placed over the needle ends prevent source dislodgement and the system is enveloped with gauze bandages (abdominal pads).

Pain Control and Postoperative Care of the Patient

Epidural anesthesia is continued during the implant. Alternatively, oral, intramuscular, or intravenous (including patient controlled analgesia [PCA]) pain medications can be used [27,50]. An air bed provides further comfort. Elastic thigh-high stockings (Ted hose) and sequential compression devices are maintained on the legs to reduce the risk of thromboembolic events. Patients are log-rolled once per shift to change their underlying chucks and to check for fecal material or pressure decubiti. Low residue diet and Lomotil three to four times per day are given to prevent bowel movements. Intravenous antibiotics are continued throughout the implant. Routine radiation precautions are in effect once the radioactive sources are loaded.

Applicator Removal and Post-Implant Care

The applicator is removed at bedside after source extraction. Epidural intravenous, or intramuscular pain medication bolus is given 15–30 minutes prior to needle removal. Should bleeding occur, pressure applied to the perineum is usually effective [13,23]. The patient is usually seen the week after the implant to initiate external pelvic sidewall boosting and for assessment of acute reactions. Slight vaginal discharge and voiding discomfort

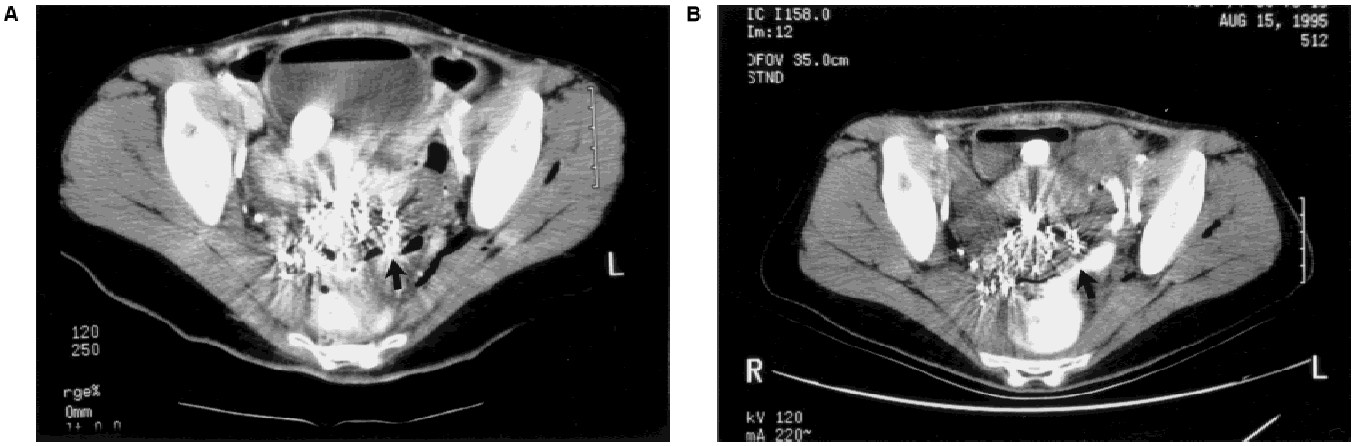

Fig. 5. **A:** Axial CT identifying needles penetrating sigmoid (arrow) with subsequent removal prior to loading **(B).**

are expected. Any inflammation around the suture sites quickly resolves with proper care. Perineal cellulitis is rare if proper outpatient perineal care and oral antibiotics are used.

Dosimetric Analysis

Computer-generated dosimetry is usually used to define the desired dose rates to structures of interest based upon the orthogonal X-rays taken following implantation [51,52]. CT imaging following needle implantation has proven very helpful to identify tumor volume and critical normal structures (Fig. 4), confirm the adequacy of needle placement in relation to these structures or needed adjustments (Fig. 5, Fig. 6A), analyze and manipulate the dose distribution as it relates to these structures (Fig. 6B), and assist with dose specification and the integration of external beam irradiation [48]. With epidural anesthesia, the needles and tandem can be manipulated outside the operating room if necessary. Modification of the planned source placement based upon the location of specific needles and critical structures can therefore be made before or after source loading (Fig. 6A).

Traditional low dose rates are the goal [1,18,23,51,53], achieved through differential loading (core sources $\leqslant$½ activity of peripheral sources) of low activity sources. ''Reference'' dose rates of 60–80 cGy/hr, ''point A'' dose rates of 50–80 cGy/hr, obturator surface dose rates of 80–100 cGy/hr, and bladder and rectal dose rates <80% of the reference dose rate are desired. The implant dose rates as well as the dose homogeneity and distribution can be manipulated by selectively changing the activity associated with a particular needle or needles or by selectively unloading, either immediately, or during the implant, strategic needles in the pattern.

Typically, total doses to the tumor volume or reference isodose from the implant range from 25–40 Gy over 2–4 days [1,18,23,51,53]. Total doses to ''point A,'' the rectosigmoid, bladder, obturator surface, and pelvic sidewall are also tabulated, as are significant hot spots.

External whole pelvic irradiation (39.6–45.0 Gy) generally precedes implantation. One or two interstitial implants are typically recommended 1–2 weeks following external beam. In some patients preceding intracavitary implants will have also been performed. After the implant, external irradiation resumes the following week using a wide midline block corresponding to the lateral boundaries of the needles to deliver 45.0–50.4 Gy through AP-PA ''split pelvic'' fields. Reduced AP-PA pelvic sidewall boosts are sometimes given to total doses of 59.6 Gy. The total tumor dose from combined implant and external beam approximates 70–85 Gy over 8 weeks.

RESULTS

Results from large series using the Syed-Neblett or MUPIT systems for various gynecologic sites are listed in Table II detailing local control, survival, and complication rates particularly for cervical and vaginal cancers [1,16–20,22,23,35,38,40,42,46,47,50,53–56].

Vulva

Interstitial implantation of locally advanced, or recurrent vulvar lesions, or medically inoperable patients is reported in several series, using the Syed-Neblett or MUPIT systems, other template systems or free-hand plastic tube techniques [12,20,42,50,57]. Lesions near the urethra or clitoris may be particularly suited to this approach to avoid mutilating surgery. High dose rate techniques have been recently described [26,58].

Recurrent Disease

Reirradiation of recurrent gynecologic malignancies with interstitial implantation following prior radiation with or without surgery was introduced by Syed in 1975 [59] and results subsequently reported by Puthawala et

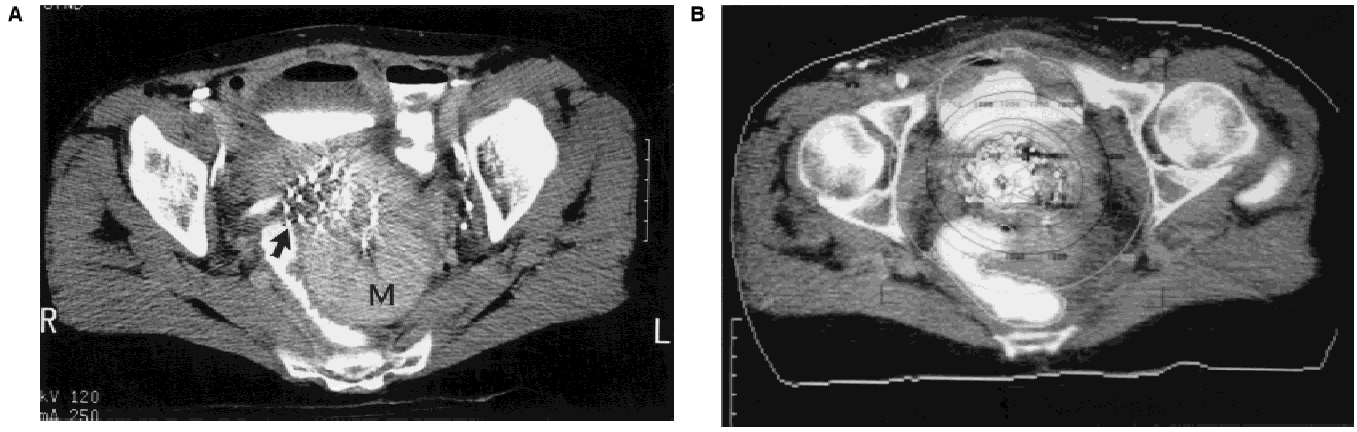

Fig. 6. **A:** Axial CT demonstrating circuitous rectosigmoid distinguished with contrast. Note: needle (arrow) in close proximity to rectum which was not loaded. Note: Large uterine myoma which is not traversed by needles (M). **B:** Same patient, lower axial level with dose distribution superimposed on the axial CT. Note: Contrast-defined bladder and rectum intersected by the isodose distribution. This enables direct visualization of the dose distribution throughout the tumor volume, bladder, and rectum. (Reprinted with permission from Erickson B, Albano K, Gillin M: CT guided interstitial implantation of gynecologic malignancies. *International Journal of Radiation Oncology • Biology • Physics* 1996; 36:699–709. Elsevier Science Inc.)

al. [46] (Table II). Laparotomy was performed in the majority of these patients treated from 1975 to 1978. The advantages of laparotomy included: 1) direct visualization of recurrent disease; 2) separation of bowel adhesions; 3) tumor biopsy and reductive surgery; 4) placement of needles under direct vision and palpation; 5) ability to perform permanent seed implants for disease not encompassed by needles; 6) ability to separate the small bowel from the needles with an omental pedicle graft as well as to separate the bladder and rectum from the tumor [46,56]. Similarly, for patients with disease involving the upper vagina following hysterectomy (recurrent cervical carcinoma after hysterectomy or vaginal recurrence of endometrial carcinoma), an open implant technique is recommended to achieve optimum needle placement [41,45]. Monk et al. [47] (Table II) concluded that patients with one rather than two interstitial implants, with sidewall involvement, tumors greater than 6 cm, previous pelvic irradiation, or persistent disease after open interstitial implant were not salvaged. Dose intensity was predictive of survival with all long term disease free survivors receiving a total dose of 80–90 Gy after external beam, open implant, and a second closed implant. Use of the Syed-Neblett system with or without permanent seed insertion [60] the MUPIT [12,20] or other template systems [28,29,32] are reported. High dose rate and plastic tube techniques have also been described [21,26,61,62].

DISCUSSION

Complications

Perhaps the greatest impediment to the universal acceptance and utilization of interstitial implantation techniques in the treatment of gynecologic malignancies is the risk of serious complications. When first introduced in 1974, the Syed-Neblett vaginal obturator surface was routinely loaded, usually in association with a central intrauterine tandem [15–17,22,56]. Long-term follow-up, however, revealed a substantial incidence of rectovaginal and vesicovaginal fistulae, and vaginal necrosis [22,56]. Tandem sources in close proximity to obturator sources created a central ''hot spot'' adding to mucosal injury leading to vaginal necrosis and fistulae and bladder and rectal injury [1]. Later recommendations were that the obturator needles should not be loaded in the presence of protruding vaginal sources in the tandem, or even in the absence of a tandem [22,23,38,40,54], and that concomitant tandem sources should be omitted if the obturator surface needles were to be loaded [1,35,54]. We use a sleeve to cover the vaginal obturator needle as a helpful alternative [36]. An intrauterine tandem may be needed if there is disease in the lower uterine segment or distal vagina but is unnecessary when treating vaginal disease without cervical involvement [18]. Use of lower activity cesium sources in the tandem or Ir-192 sources instead may make use of the tandem safer [23,48,53]. Use of lower activity, shorter Ir-192 sources in the needles along with differential loading to control dose rates and reduce hot spots, and limiting the total dose within the implant lead to a reduction in complications as has the use of computerized dosimetry to define these dose rates [1,22,23,54]. Refraining from insertion of sources in template positions close to the bladder and rectum is also beneficial as is the use of one vs. two implants [22,23,40]. Attention to rectal dose rates and total external beam dose is important [40,50,53]. The proximity of the needles to the rectum and needle convergence may be predictive of complications [22,23,35]. Use of chemotherapy has also been implicated in the development of complications [63].

TABLE II. Interstitial Implantation Series

Series	Site and stage	Number of patients	Local control	Survival (N)	Complications (N)
Feder et al. [16]	**Cervix**	**38**		60% NED at 24 mo.	8%
1974–1976	III	35	60% at 24 mo. (avg. F/U)		*Necrosis of cervix* (2)
	IVA	3	0% at 24 mo. (avg. F/U)		Paravaginal abscess (1)
Pre-modification Syed-Neblett system			(16–40 mo.)		
Gaddis et al. [22]	**Cervix**	**75**	70.7% at med. F/U 17 mo. (3–60 mo.)		Adverse (16/75) 21.3%
1975–1979					
	IB	14	64.3%		*Fistulae* (10/75) 13.3%
	IIA	8	100%	Stage II—68% at 24 mo.	Med. time = 11 mo. (5–19 mo.)
	IIB	25	80%		*Grade III non-fistulous* (6/75) 8%
Pre-modification	III	26	53.8%	Stage III—38.5% at 12 mo.	(Proctosigmoiditis; cystitis, vault necrosis)
Syed-Neblett system	IVA	2	100%		
			Med. time to recurrence 6 mo. (1–28 mo.)		Grade II (13/75) 17%
Syed et al. [23]	**Cervix**	**60**	78% at med. F/U 48 mo.	58% overall actuarial DFS	Serious 3%
1977–1982	IB	6	100% (minimum F/U = 36 mo.)	83%	*Fistulae* 14%
	IIA	2	100%	100%	Cystitis (3/60) 5%
Post-modification	IIB	21	72%	67%	Proctitis (3/60) 5%
Syed-Neblett system	IIIB	26	77%	50%	
	IVA	5	80%	20%	
Aristizabal et al. [38]	**Cervix**	**21**	85% at 26 mo. (15–48) mean F/U		*Grades II and III* (7/21) 33%)
1978–1981	IB	2	100%		*Fistulae* (3) 14%
	IIB	3	100%		*Vag. necrosis (1)*
Pre-modification	IIIB	15	86%		Proctitis and Cystitis (3)
Syed-Neblett system	IVA	1	0%		
Aristizabal et al. [40]	**Cervix**	**118**			*Grade III* (14/118) 12%
1978–1982	IIB	41	76%		*Fistulae*—8%
	IIIB	77	74%		Grade II (11/118) 9%
Post-modification			at mean F/U 29 mo. (24–64 mo.)		Grade I—33%
Syed-Neblett system					
Vermund et al. [55]	**Cervix**	**27**		41% (11/27) NED	*Major* (9/27) 33%
1985–1991	IB	4		1/4	*RV fistula* (3) 11%
	IIA	1		0/1	*Vag. fistula (1)*
	IIB	8		4/8	*Colostomy* (3) 1.1% (proctitis and abscess)
	IIIA	3		1/3	Sigmoid stricture (1)
Syed-Neblett system	IIIB	11		5/11	Ureteral stenosis (2) (with urinary incontinence, 1)
Fleming et al. [17]	**Vagina**	**13**	77% at 3–20 mo.	(10/13) NED at 3–20 mo.	(3/13) 23%
1976–1978	I	3			Vag. ulcer (1 at 1 mo.)
	II	9			*Vag. necrosis* (2 at 4–12 mo.)
Pre-modification Syed-Neblett system	III	1			

continued

TABLE II. Interstitial Implantation Series (*Continued*)

Series	Site and stage	Number of patients	Local control	Survival	Complications
Puthawala et al. [56]	**Vagina**	**27**	85% at med. 50 mo. (40–84 mo)	56% NED at med. of 50 mo.	*Major* (4/27) 15%
1976–1979	I	1	100%		*RV fistula* (2) 7%
	IIA	7	100%	37% distant metastases	*Necrosis* (4) 15% at 8–14 mo.
	IIB	9	78%		Superficial vag. necrosis (7) at 4–8 wk after XRT
Pre-modification	III	9	78%		
Syed-Neblett system	IV	1	100%		Vag. stenosis (3)
			Local failure at 8–40 mo.		
Ampuero et al. [1]	**Cervix**	**24**	54% at 25–41 mo.	25% (6/24) NED at 25–41 mo.	(9/24) 37.5%
1978–1980	IB	1	0%		*RV fistula* (1)
	II	6	30%		Rectal stricture (4)
	III	11	63.6%		Hemorrhagic proctitis (4)
	IV	3	66.7%		*Colostomy* (1)
Pre-modification	**Recurrent**	**3**	33%		(7–24 mo. after XRT—med. 12 mo.)
Syed-Neblett system	**Vagina**	**4**	100% at 49–51 mo.	75% (3/4) NED at 49–51 mo.	(3/4) 75%
	I	1		(1/4) DSD at 5 mo.	*Rectal stricture with colostomy* (1)
	II	1			Hemorrhagic proctits (1)
	III	1			*Vag. necrosis* (1)
	IV	1			
Erickson et al. [54]	**Cervix**	**32**	74% at 17 mo. med. F/U (2–58 mo.)		(4/51) 8%
1978–1987	IB	4	100%		Radiation colitis (1)
	IIA	1	100%		(Colostomy at 10 mo. (2%))
	IIB	10	86%		
	IIIA	5	40%		Proctitis and bleeding (2) at 9–10 mo.
Post-modification	IIIB	12	73%		
Syed-Neblett system	**Vagina**	**9**	72% at 16 mo. med. F/U (2–62 mo.)		
	I	3			
	II	6			
	Sarcoma	**3**	67% at 14 mo. med. F/U (11–32 mo.)		
	IIA	1			
	IIIA	2			
	Myometrium	**1**			
	Recurrent	**6**	1/6		
			70% at med. 18 mo. (2–62)		
Konski et al. [50]			87% (all pts.)	Mean survival time = 16 mo. (1.2–31.0 mo.)	*Major* (4/23) 17%
1990–1993	**Cervix**	**17**	88%		VV fistula (1)
	Vagina	**5**	80%		RV fistula (1)
	Endometrium	**1**	100%		Rectal ulcer with bleeding (2)
			Mean time to failure = 8.5 mo. (0.8–30.1 mo.)	Mean survival time = 20 mo. (5.7–34 mo.)	*Minor* (6/23) 26%
					Rectal bleeding (6)
Syed-Neblett system	**Recurrent**	**7**	100%		Mean 8.4 mo. (2.5–16.5 mo.)
	Vulva			17% distant failure	Hematuria (1)
	Endometrium				Ureteral stricture (1)

continued

TABLE II. Interstitial Implantation Series (*Continued*)

Series	Site and stage	Number of patients	Local control	Survival	Complications
Fontanesi et al. [53]			83% (26/30) (all pts.)	60% (18/30) NED at 36 mo.	*RV fistula and/or colostomy* (6/30)
1984–1991	**Cervix**	**24**	87% at med. F/U 36 mo. (4–84)	(4–84 mo.)	20% at 6–16 mo.
	II	5			*Vag. necrosis* - (2) at 8–12 mo.
	III	16			Hematuria (1) at 40 mo.
Syed-Neblett system	IV	3			Radiation proctitis (9/30) 30%
	Vagina	**6**	100% at med. F/U 36 mo. (4–84)		
	III	1	Interval to recur = 5–9 mo.		
	IV	5			
Kumar et al. [53]	**Cervix**	**3**	33% (1/3) at 12 mo.		SBO with ileal resection (1)
1979–1985	(stump)		Two failures at 5 and 7 mo.		
	Recurrent	**4**			
Syed-Neblett system	Cervix				
Rush et al. [42]					(4/16) 25%
1988–1990	**Cervix**	**5**	80% at 10–23 mo.		*Enteric fistula* (1)
	Vagina	**2**	50% at 28–44 mo.		*Other fistula* (2)
	Endometrium	**1**	0% at 6 mo.		*Necrosis* (1)
	Recurrent	**8**			
	Cervix	2	100% at 24–49 mo.		
	Vulva	3	66% at 12–30 mo.	75% at 8–38 mo.	
Syed-Neblett system	Endometrium	3	66% at 12–30 mo.		
Puthawala et al. [46]	**Recurrent**	**26**	62% (16/26)	NED	15%
1975–1978	Cervix	14	50%	29% (4/14)	
	Endometrium	5	100%	40% (2/5)	
	Vagina	5	60%	20% (1/5)	
Pre-modification	Ovary	2	50%	50% (1/2)	
Syed-Neblett system			Minimum F/U = 24 mo.		
Monk et al. [47]	**Recurrent**	**28**	71% at med. F/U 44 mo.	36% (10/28) NED at med. 44 mo.	(3/28) 11%
1984–1989	Cervix	18		33% (4/10)	*VV + RV fistula* (1)
	Endometrium	10		40% (6/18)	*SBO + ureteral stricture* (1)
Syed-Neblett system					*Ureterointestinal fistula* (1)
Martinez et al. [18, 19]	**Cervix**	**37**	83.8% at 1–7.5 yr.		5.4%
1976–1983	IIB				*Urinary diversion* (1)
	IIIB				Rectal ulcer (1) at 14 mo.
Stanford/Mayo Clinic	**Vaginal**	**26**	80.8% at 1–7.0 yr.		8%
MUPIT system	**Urethral**				*Colostomy* (1)
			All local failures within 15 mo.		*Urinary diversion* 1
Hughes-Davis et al. [20]	**Cervix**	**70**	25% (all pts.)	DFS at 5 yrs—22%	*Fistula* (18) 13%
1977–1992	IB/IIA	10			*Bladder* (17) 12%
	IIB/Barrel	28	22%	36%	*Bowel* (*colostomy*) (28) 20%
Stanford/Harvard	IIIA	5			*Late Mortality* (3) 2%
	IIIB	21	44%	18% 3 yr.	
MUPIT system	IVA	6			
	Vagina/vulva	**20**			
	Recurrent	**37**			
	Cervix	23	36%	26%	
	Endometrium	14			

Significant complications are italicized.

Avg., average; DFS, disease free survival; DSD, dead without disease; F/U, follow-up; med., median; mo., months; MUPIT, Martinez Universal Perineal Interstitial Template; NED, no evidence of disease; pts., patients; RV, rectovaginal; SBO, small bowel obstruction; vag., vaginal; VV, vesicovaginal; wk., weeks; XRT, radiation therapy yr., years.

With these modifications, serious complications were decreased from 8% in Syed's first reported series to 3% [23], from 33% to 16% in Aristizabel's experience [40] and from 42% to 8% in Amupero's and Erickson's series [1,54].

Other Techniques

Free-hand rather than template-guided insertion of plastic tubes or needles in single or double planes, is preferred at some institutions [6,12,42,61,62,64,65]. Skill is required to insert the needles in a parallel and uniform direction. Absence of the template does allow direct palpation of disease through the vagina to guide implantation as well as displacement of the uninvolved vagina, bladder, and rectum with packing. Limitations of such techniques include convergence or divergence of the needles or tubes and a non-fixed relationship between the interstitial and intracavitary components of the system. Such techniques may however be invaluable in patients with small residuum after external beam, periurethral disease, or perineal disease.

Permanent seed implantation suffers from some of the same unpredictability of dose distribution but may be useful in disease sites such as the pelvic wall which are inaccessible to needle implantation, particularly when laparotomy is employed [6,46,61,62,65].

CONCLUSION

Interstitial implantation of gynecologic malignancies is invaluable in the setting of extensive or large volume disease, anatomical distortion, and recurrent disease. Such techniques are a necessary component of the brachytherapy services available to patients as a superior alternative to external beam alone or inadequate intracavitary applications. It is, however, extremely important to understand the potential for morbidity with interstitial techniques. Manipulation and control of dose rate and total dose through selection of needle site insertion, source activity, dose specification, and duration of implantation and careful integration with external irradiation are essential to achieving local tumor control with an acceptable risk of complications in patients with these challenging clinical presentations.

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